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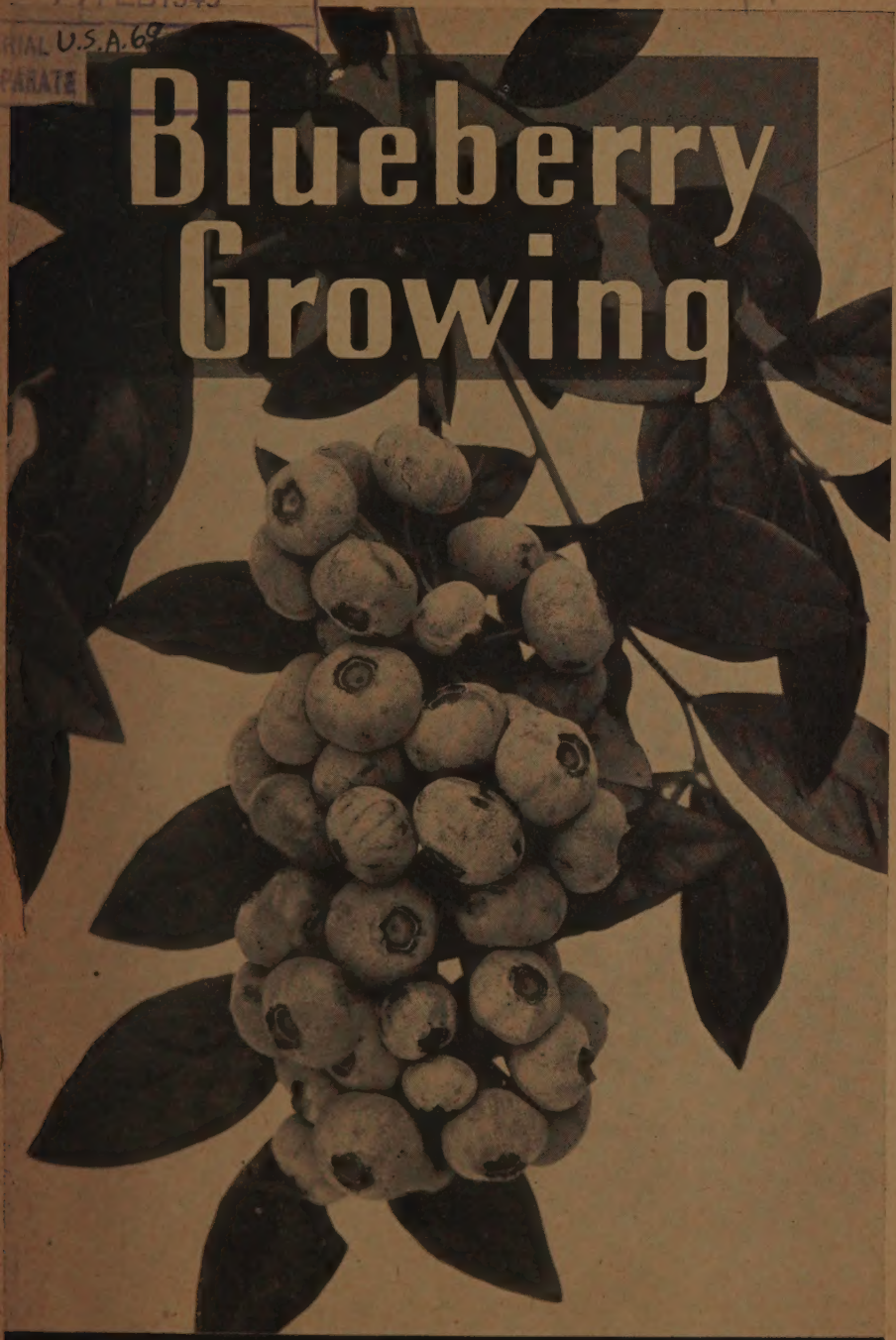
Blueberry Growing



U. S. DEPARTMENT of AGRICULTURE
FARMERS' BULLETIN NO. 1951

1944

CULTIVATED BLUEBERRIES constitute a new and valuable crop in New Jersey, North Carolina, Michigan, Washington, Oregon, Massachusetts, New York, and other States. The industry is based chiefly on the productive large-fruited varieties of the highbush blueberry obtained since breeding work was begun by the United States Department of Agriculture in 1909. However, some commercial plantings of the rabbiteye blueberry have been made in the Southeast. The available information on selecting and growing varieties of both these species in home gardens and commercial plantings and protecting them from diseases and insects is summarized in this bulletin.

In addition the many wild species of blueberries gathered in large quantities for sale are discussed briefly.

Growers should all remember that blueberries flourish only on acid soil and that stable manure and leguminous mulch are not usually suitable for blueberry fields, but may actually kill the plants.

This bulletin supersedes Leaflet 201, Blueberries.

Washington, D. C. Issued May 1944

Blueberry Growing

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DEVELOPMENT OF BLUEBERRY INDUSTRY[2]

BLUEBERRIES, originally native North American wild fruits, are becoming an increasingly important cultivated crop in different parts of the United States. Besides having great taste appeal, they are good sources of vitamin C and also contain other vitamins and essential nutrients. They can be marketed fresh, canned, or frozen.

[1] Sections on varieties and culture prepared by George M. Darrow; sections on diseases and insects prepared by R. B. Wilcox and Charles S. Beckwith, respectively.

[2] The name "blueberry," as used in this bulletin designates the group of plants, commonly called "blueberries" and "huckleberries," that have many very small, soft seeds in contrast to the true huckleberries, which have 10 large, bony seeds.

FIGURE 1.—Berries from different sources: *A*, Rubel the best highbush selection from the wild; *B*, wild highbush blueberry of eastern United States; *C*, wild lowbush blueberry of the Northern States; *D*, cross of two highbush varieties. Note the large size of the berries from the cross.

Prior to 1910 there were at least two cultivated plantings of highbush blueberries made with bushes selected from the wild. Subsequently [3] the breeding and selection work of the late F. V. Coville laid the foundation for a new blueberry industry. The extent of the improvement made in the blueberry by Coville is indicated in figure 1, which shows the comparative size of the fruit of one of his largest fruited seedlings (fig. 1, *D*) and of Rubel, the best selection from the wild (fig. 1, *A*).

The first commercial shipments of cultivated blueberries resulting from this work were made in 1916. In 1943 there were about 2,000 acres under cultivation in New Jersey, some 500 acres in North Carolina, 500 in Michigan, and possibly 100 in all other States, chiefly in Wash-

[3] COVILLE, F. V. EXPERIMENTS IN BLUEBERRY CULTURE. U. S. Bur. Plant Indus. Bul. 193, 100 pp., illus. 1910; DIRECTIONS FOR BLUEBERRY CULTURE, 1921. U. S. Dept. Agr. Dept. Bul. 974, 24 pp., illus. 1921. These bulletins are out of print but may be consulted in libraries.

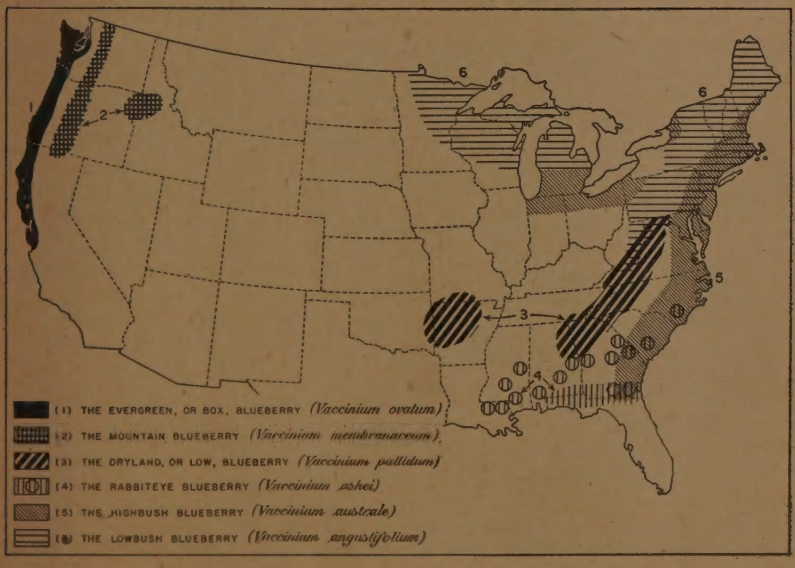
ington, Oregon, Massachusetts, and New York. For 1943 the value of the crop from cultivated fields in New Jersey was $1,000,000; in North Carolina $225,000; and in Michigan $300,000.

The first commercial planting of the rabbiteye blueberry, a wild blueberry of the South, was made by M. A. Sapp in western Florida about 1893 with bushes transplanted from the wild. Between 1920 and 1930 some 2,225 acres in Florida were set with plants transplanted from the wild or propagated from the early plantings and selections. Similar plantings were also made in Louisiana, Mississippi, Alabama, Georgia, South Carolina, and North Carolina. Few of these plantings were made with selected bushes, and since 1930 relatively few of them have been cultivated. The crop of the rabbiteye is nearly all from such plantings and very little from the wild.

Though the blueberry crop from cultivated varieties had a value of over $1,500,000 in 1943, the total value of the industry in the United States is very much greater and is based largely on various species of wild blueberries in several widely separated areas: The blueberry barrens and uplands of New England, New York, Pennsylvania, West Virginia, Michigan, Wisconsin, and Minnesota; the swamplands along the Atlantic coast and in the Northeastern States; the upland sections of Alabama, Georgia, and other Southern States; the Cascade Mountain section of Oregon and Washington; the coastal section of northern California, Oregon, and Washington. Figure 2 shows the location of the areas in the United States from which berries are most extensively harvested and marketed.

In the case of various other fruits, selection and breeding of superior varieties have enabled the grower to place on the market a product so much superior to that from the wild that relatively small quantities of such wild types are now marketed. With the blueberry, superior

FIGURE 2.—Map of the United States, showing areas in which wild blueberries are extensively harvested.



varieties of the highbush and of the rabbiteye are now being grown, and in the future these and other varieties may be expected to replace still further the fruit from the wild plants. The largest fruited varieties are being hybridized with drought-resistant species in order to obtain very large-fruited drought-resistant varieties that might also be used in erosion control. If produced at a sufficiently low cost, cultivated blueberries may replace much of the crop from the wild, now worth several million dollars annually. They also can be grown in home gardens provided the soil is sufficiently acid.

IMPORTANT SPECIES

Fruit from seven types or species of blueberries is harvested extensively in different parts of the United States and fruit from three others to a more limited extent. They are known as the lowbush (*Vaccinium angustifolium* Ait.), highbush (*V. australe* Small; in part, *V. corymbosum* L.), dryland (*V. pallidum* Ait.), evergreen (*V. ovatum* Pursh), mountain (*V. membranaceum* Dougl.), and rabbiteye (*V. ashei* Reade). In addition, commercial quantities of the Canada blueberry (*V. canadense* Kalm) are harvested in Maine, usually where it occurs with the lowbush blueberry, and in the Adirondack Mountains of New York, where it is the chief kind at the higher elevations. In the mountains of western North Carolina at least two highbush suckering blueberries (*V. alto-montanum* Ashe, its hybrids, and *V. constablaei* Gray), related to the dryland one, are also harvested commercially. Still other species are sometimes harvested over extensive areas in various regions.

LOWBUSH BLUEBERRY

The lowbush blueberry, the most important commercial species, is native to northeastern United States and parts of Canada (fig. 2). In the United States fruit from this species is gathered in commercial quantities from Maine to Minnesota and southward in the Alleghenies to West Virginia. It is an upland species, usually 6 to 18 inches high, which stools into large colonies by means of underground shoots. (See illustration, p. 1). No named varieties have been propagated for commercial planting. Selections have been made for breeding, for this species crosses readily with the highbush blueberry. Its fruit, which is usually light blue, ripens earlier than that of the highbush blueberry, but the flavor is similar. Although the fruit ripens during July and August, harvesting may extend into September in the most northern areas. The fruit is gathered for the canneries with rakes (figs. 3 and 4) similar to the cranberry scoop, but much smaller. For the fresh-fruit market the fruit is picked by hand as well as harvested with rakes. Even though only a part of the total wild crop is harvested, the annual value of the harvested fruit is probably over $5,000,000, the larger part being used by canneries.

After the forest has been cut or burned over, the lowbush blueberry comes in naturally in large areas in some of the Northern States. If burning is prevented, sooner or later the area grows up to brush and woodland again. Thus areas that yield large quantities of berries for a few years may produce none later, owing to the crowding and shading-out of the bushes. However, in eastern Maine and in some smaller areas elsewhere the fields are reburned every second or third year in

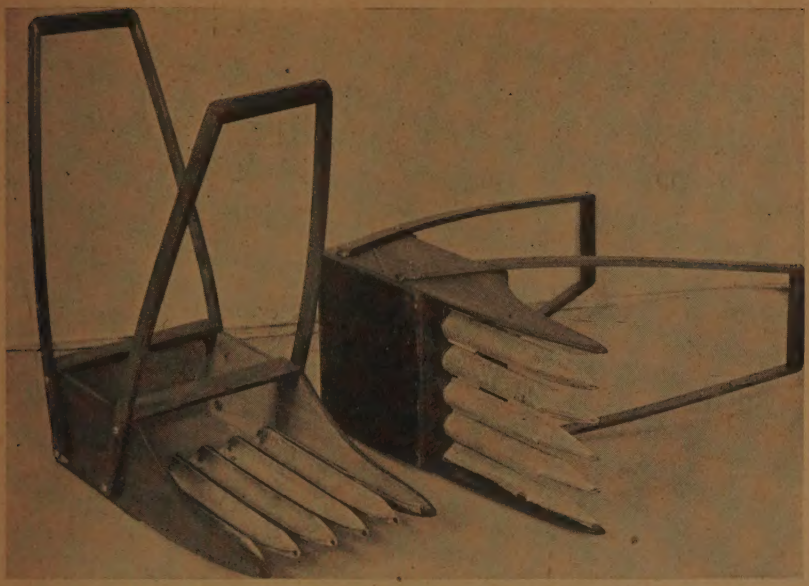


FIGURE 3.—Rake used for harvesting lowbush blueberries in Wisconsin.

the spring while the ground is still wet, to kill back weeds and underbrush (chiefly sweetfern, hardwood sprouts, lambkill, or sheep laurel, alder, and hardhack) and to prune the blueberry plants. Either hay or straw with oil is used to help the burning. As a further aid in control, weeds and bushes may be cut or pulled in the fall previous to

FIGURE 4.—Harvesting lowbush blueberries for the canneries in eastern Maine. The rake is 10 to 12 inches wide and has 18 to 40 teeth.

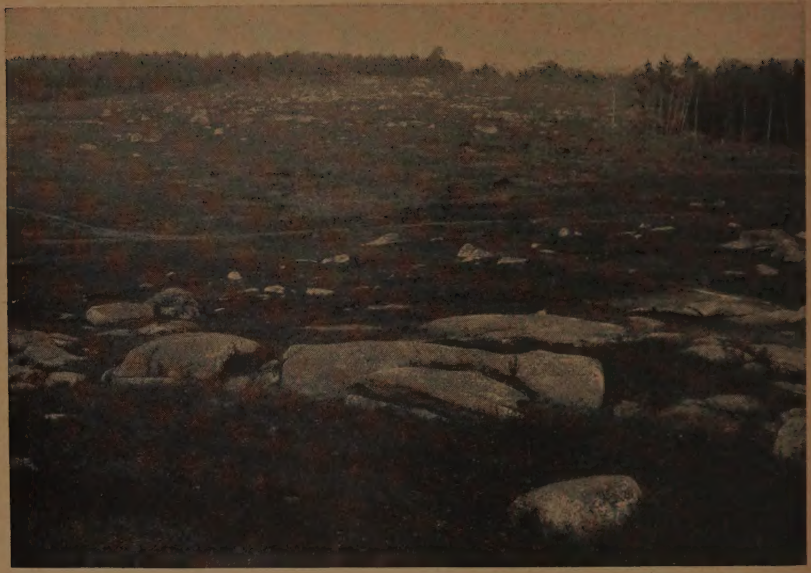


FIGURE 5.—A view of the blueberry barrens, which cover more than 100,000 acres in Washington County, Maine, about the middle of August. Most of the blueberries are the lowbush (*Vaccinium angustifolium*).

burning. Burning-over does not seriously injure the blueberry plants if properly done during the dormant season, but repeated burning lowers soil fertility. The Maine Agricultural Experiment Station reported that mowing sweetfern in July gave about 80 percent control of that weed and that 99 percent of the alder was eliminated by removal of the crowns. Dusting for control of the blueberry fruitfly (p. 34) is extensively practiced, and two applications have been found to be very successful. Early picking, before the berries are infested, is recommended. In Maine picking for the fresh-fruit market begins about July 20 and for the canneries about August 10. About 150,000 acres of native blueberries in Maine are given some care (fig. 5).

HIGHBUSH BLUEBERRY

The highbush blueberry is native from northern Florida to southern Maine and west to southern Michigan. It is gathered from the wild most extensively in eastern North Carolina and northward along the Atlantic coast to Massachusetts, but in varying quantities throughout its range. The annual value of the crop from wild plants receiving no care is probably between $1,000,000 and $1,500,000. The value of the cultivated crop in 1943 was about $1,525,000. The highbush blueberry is a native of swamps, of moist woods, and also of moist, open fields at high elevations. It grows to 10 or 15 feet in height and does not stand drought well. From this species have been selected the plants bearing fruit of large size, such as Rubel, Adams, Harding, Brooks, Sooy, Chatsworth, and Sam. Some of these selections when hybridized have produced the still larger fruited named varieties that are extensively propagated.

The dryland blueberry, also commonly called "low huckleberry," is native from Georgia and Alabama to Maine and westward to Michigan and Oklahoma, but it is important chiefly in northern Alabama and Georgia and northward to Maryland and West Virginia. The plants grow in the dry, relatively poor soils of the ridges and hills and are very drought-resistant. The fruit is gathered most extensively in northeastern Alabama and northwestern Georgia, West Virginia, and western and northwestern Arkansas. The dryland blueberry grows from 1 to 3 feet in height and spreads in colonies much as does the lowbush blueberry. The berries have a light-blue color, and their flavor is good. They have a small, rather dry scar where the stem was attached. The dryland blueberry commonly ripens later than either the lowbush or the highbush blueberry and is sometimes called the late blueberry. However, in Georgia and Alabama it ripens before the crop from cultivated fields in New Jersey and brings good prices in

FIGURE 6.—Shoots of the evergreen blueberry, showing flower buds and flowers (*A*) at most nodes and (*B*) at upper nodes only.

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markets. The annual value of the harvested crop, all from wild plants, may average $300,000; in some years it is much more. No varieties of the dryland blueberry have been named and introduced. The usual low form of this blueberry does not hybridize with the highbush. However, vigorous taller plants of this general type that bear larger berries than the usual low form and do cross with the highbush varieties have been found in Georgia and Alabama. Recent evidence indicates that this large-fruited dryland blueberry may be the more important commercially in those States.

EVERGREEN BLUEBERRY

The evergreen blueberry, commonly known as evergreen, or coast, "huckleberry," is native along the Pacific coast from central California to British Columbia. The fruit is gathered extensively in northern California, along the coast of Oregon and Washington, and in the Puget Sound district. Branches of this blueberry are important commercially for decorative purposes, being shipped by the carload to eastern cities under the trade name "evergreen huckleberry," chiefly from December to March. The branches for shipment are gathered in open woodland where there is part shade. The plant is also an attractive ornamental shrub in flower and fruit as well as in leaf (figs. 6 and 7). It may reach a height of 20 feet in open woods. No commercial plantings for fruit production are known. The annual value of the fruit crop may be $150,000 to $200,000 and that of branches an equal amount.

FIGURE 7.—Branches showing the fruiting habit of the evergreen blueberry of the Pacific coast.

FIGURE 8.—Rooted cuttings of the evergreen blueberry, which is propagated relatively easily by means of cuttings having 4 to 6 leaves, taken during the winter.

The berries ripen from August to November, but the chief shipments are made in September and October. The berries are usually small and shiny black and have a characteristic strong flavor not at all like that of other blueberries. This flavor makes them less desirable than other blueberries for eating fresh. However, they are extensively used for pies and otherwise in cooking. A variation with slightly bluish fruit is not uncommon. A large part of the crop is stored frozen for use by pie makers.

The evergreen blueberry grows only in the mild climate near the Pacific coast and around Puget Sound; it has not been hardy in eastern United States where tested. Because of this lack of hardiness, selections of superior wild forms should be tested only in western Washington and Oregon and in northwestern California. Cuttings, 6 to 8 inches long, with four to six of the upper leaves left on, taken during the winter, are readily rooted (fig. 8).

FIGURE 9.—A branch of the mountain blueberry, gathered extensively in the Cascade Mountains of Oregon and Washington.

MOUNTAIN BLUEBERRY

The mountain blueberry, also called "broadleafed huckleberry," is a native of the high slopes of the Cascade Mountains of Oregon and Washington and eastward to Wisconsin. It is most abundant near Crater Lake, Mount Hood, Mount Adams, and Mount Rainier, where thousands of visitors pick the fruit each year. It is a very drought-resistant plant, matures its fruit in the late summer even after 3 or 4 rainless months, and is important for forage. The plants grow 3 to 5 feet high and are abundant in burned-over areas. In the Cascade Mountain area at least it is one of the best flavored and uniformly largest fruited of all wild blueberries. The annual value of the fruit crop may total $200,000. The berries are somewhat pear-shaped, black or maroon in color, juicy, high-flavored, and rather tart but not too tart to be eaten fresh. Because its berries are borne singly (fig. 9) or in pairs rather than in clusters like those of the other blueberries, the individual bushes are not highly productive and are not likely to become important under cultivation. No cultivated plantings are known.

RABBITEYE BLUEBERRY

The rabbiteye blueberry is native to river valleys and the edge of woods in southern Georgia, southern Alabama, and northern Florida. It is harvested from the wild to a very limited extent. It is chiefly important because it grows on locations with more upland conditions than the highbush. Also, it is not so sensitive to soil acidity and is far more heat- and drought-resistant than the highbush. More than 3,500 acres located mostly in northwestern Florida but also in North Carolina, South Carolina, Georgia, Alabama, Mississippi, and Louisiana have been devoted to this species, the plants having been transplanted from the wild into commercial fields. No figures on the market value of the crop of this blueberry are available.

Because much fruit shipped from the South has come from the unselected bushes, many of which produce small, gritty-fleshed berries, lacking in flavor, the rabbiteye has had a poor reputation in markets. The berries are mostly black and not so attractive as the blue-fruited species and varieties. However, some named rabbiteye varieties bear large, juicy, aromatic, blue fruit, which compares favorably with that borne by selections of other species.

BLUEBERRIES FOR THE HOME GARDEN

Blueberries can be produced in home gardens if the soil is naturally acid or is properly treated. They do not succeed in ordinary rich garden soils and soon die, but they do thrive in naturally moist acid soils such as those in which native blueberries and huckleberries, azaleas, laurel, and rhododendrons grow. For small plantings mulching with leaves, sawdust, hay, or straw to a depth of 5 or 6 inches helps to retain moisture, to keep down weeds, to control erosion, and to keep the ground cool. Blueberries should not be planted on soils limed in recent years unless actual tests have shown that they are still acid enough for blueberries. For the less acid soils, decaying oak leaves or acid peat mixed in the soil around the plants helps to make conditions suitable, but plants on such soils will always require extra care.

At least two varieties should be planted to provide for cross-pollination.

In the Southern States from eastern North Carolina to Florida and west to Arkansas and Louisiana, varieties of the rabbiteye blueberry may be grown in home gardens. Three plants each of Myers and Owens might be selected.

From Maryland to southern Maine and west to Michigan wherever the soils are sufficiently acid and moist the highbush varieties may be grown in home gardens. In New Jersey, June may be selected as a good early variety, Stanley as a midseason variety, and Dixi, Atlantic, Pemberton, and Burlington as late varieties. In New England Cabot may be used as an early variety; Pioneer, as a midseason variety; and Wareham, as a late variety. In Michigan Cabot or Adams is suggested as the early variety, Pioneer as midseason, and Jersey as the late. For North Carolina gardens June is a good early variety; Scammell a late midseason; and Jersey a late. On the more upland soils, Adams is more productive than most varieties. It ripens with Cabot and has nearly as long a season as Cabot.

RABBITEYE VARIETIES AND THEIR CULTURE

The rabbiteye blueberries are suggested for local market and home use in the Coastal Plain and a part of the Piedmont from eastern North Carolina to northern Florida and to Louisiana and Arkansas. Limited tests for general market are suggested for the same area.

The rabbiteye blueberries (figs. 10, 11, and 12) are generally set in midwinter about 15 by 15 feet. Under good conditions they grow rapidly and bear commercial crops by the third year. They respond to cultivation or mulching and fertilization. In one planting in southern Georgia, the average annual yield of the Black Giant for the first 11 years of bearing was 9 quarts per plant; the eleventh year the yield was 30 quarts per plant. Pruning is not generally practiced, but be-

cause the fruiting habit of the rabbiteye is very like that of the highbush blueberry some pruning of older bushes is considered desirable. The older stems and the smaller young shoots may need thinning to prevent the bushes from becoming too dense; pruning should be relatively light, however, because the rabbiteye blueberry is sufficiently vigorous to support and bring to large size large crops of fruit.

Under the same growing conditions, the fruit of rabbiteye blueberry ripens later and over a longer season than that of the highbush and dryland blueberries. Picking in north Florida usually begins near the end of May. Some varieties of rabbiteye blueberry ripen most of their fruit within a 30-day period, whereas other varieties may mature fruit over a period of 3 months, extending into September. The rabbiteye blueberry has firmer fruit with a much smaller scar where the berry is picked from the stem than does the highbush blueberry; hence it withstands shipment better than the latter.

Characteristics of some rabbiteye varieties are given in table 1. The Black Giant, Hagood, Owens, and Myers are some of the better selections from the wild that have been propagated. The Black Giant is fairly early, has large black rather soft fruit, and ripens over a

FIGURE 10.—Mature rabbiteye blueberry bushes at Crestview, Fla., showing the many shoots and great height of this species. Note that the third and fourth bushes in the row have not grown so tall as the first bush.

FIGURE 11.—A planting of rabbiteye blueberry at Crestview, Fla. Plantings of 50 to 100 acres are not uncommon.

period of nearly 60 days. It produces very large bushes. Its branches are stout, and it needs to be kept low for ease of picking. The Hagood is fairly early, has large nearly black fruit, is very productive, and has a longer fruiting season than Black Giant. It is also very vigorous. The Owens is also erect and tall, but it has tough branches that do not break easily on bending. Its fruit is large and black and ripens late. It has large, open fruit clusters and a very long season of about 3 months. The Myers ripens its fruit slightly later than some others. The berries are light blue and of good quality. It is one of the best varieties, though it is not so large-fruited as Black Giant.

Other less promising or less known named varieties are Ruby, Mineola, Sapp Early (early), Anne, Scott, Jean, Suwanee, Clara, Walker, Locke, and Okaloosa (very late). The Ruby has light-blue berries of large size, but they possess grit cells and are not so well-flavored as those of the previously mentioned varieties. The plant is not so tall as most others. Clara has the best flavored fruit of all and ships well, but it is hard to propagate. Walker is rather early and has blue, good-quality fruit. The Sapp Early is large-fruited and early and matures its fruit in a short period. It is very productive

TABLE 1.—*Rabbiteye blueberry varieties ranked approximately in order of importance with reference to certain characteristics*

Rank	Season (early to late)	Size of berry (large to small)	Dessert quality (good to poorer)	Color (light blue to black)	Suckers (many to few)
1	Ruby.	Ruby.	Clara.	Ruby.	Myers.
2	Hagood.[1]	Black Giant.	Myers.	Myers.	Hagood.
3	Jean.	Owens.	Scott.	Clara.	Jean.
4	Black Giant.	Jean.	Owens.	Suwanee.	Ruby.
5	Myers.	Hagood.	Jean.	Jean.	Suwanee.
6	Clara.	Clara.	Black Giant.	Owens.	Scott.
7	Suwanee.	Scott.	Hagood.	Scott.	Owens.
8	Owens.[1]	Myers.	Suwanee.	Hagood.	Black Giant.
9	Scott.	Suwanee.	Ruby.	Black Giant.	Clara.

[1] Long fruiting season.

and has good-quality fruit. It seems to need only a very short winter rest period; its buds start early and may be killed by late frosts if planted north of the Coastal Plain section of Georgia and Alabama.

Other promising varieties have been selected and are being propagated for general planting. As far as they have been observed, the named varieties, except Locke, have been so resistant to stem canker (a serious southern disease) that no infections have been found on them. Future plantings should consist entirely of the more desirable named varieties. Alternate rows should be planted to different varieties because cross-pollination is necessary.

Propagation has been chiefly by offshoots, or suckers, which arise at distances of a few inches to 8 feet from the parent plant. These are usually grown in the nursery for a year before being set in their permanent location. Recently large-scale propagation by winter and summer cuttings, the same as for the highbush blueberry, has been successful, with an even larger percentage of the cuttings rooting than of the highbush blueberry (p. 24).

FIGURE 12.—Rabbiteye blueberry plant from a strong offshoot set in March of the year before the photograph was taken at Crestview, Fla., July 30.

HIGHBUSH VARIETIES AND THEIR CULTURE

SOIL AND CLIMATIC REQUIREMENTS

The highbush blueberry is found in the wild only where the soil is very acid and moist. Usually the best growth occurs where the acidity ranges from pH 4.3 to 4.8, and cultivated plantings have succeeded on such acid soils. Good growth may occur in soils with a pH value as low as 4; however, where the acidity is as low as pH 4, application of hydrated lime at the rate of about 1,000 pounds per acre should be tried and will usually result in much better growth; where the acidity is as high as pH 5, finely ground sulfur [4] or ammonium sulfate may be used. If the soil is sandy or sandy containing some peat, ammonium sulfate should be used as it both acidifies the soil and furnishes nitrogen. If the soil is a loam, it may contain enough nitrogen and sulfur may be used to acidify it.

There are some small vigorous plantings on soils where blueberries or their relatives are not native, but as such instances are few it is not advisable to make commercial plantings on such soils. The best indication that blueberries may succeed on any soil is that they or some related plants, such as huckleberries, azaleas, or laurel, are found growing there naturally. Open porous soils, such as a sand-peat mixture with an admixture of loam, with the water table 14 to 30 inches below the surface, have been found best for blueberries.

The cultivated highbush blueberry is raised commercially from eastern North Carolina northward to southern New England and also in western New York, in southern Michigan, and in western Oregon and Washington. The plant is probably not hardy north of southern Maine and central Michigan, as it does not stand temperatures of about −20° F. or lower. Instances have been reported of the tops being killed in the ground or to snow level at a temperature of −30°. However, even in sections where the blueberry is not generally hardy, local conditions of air drainage, or protection by deep snow may make blueberry growing possible. The southern limit for present-day highbush varieties is about 100 miles north of the Gulf of Mexico from Georgia to Louisiana. In Florida, southern Georgia, and southern Louisiana the cold period is so short that the bushes do not break their winter rest period and blossom normally. They probably need about the same amount of cold in winter as does the Elberta peach. However, the Cabot variety grows more vigorously in Massachusetts and Michigan than in eastern North Carolina so that the longer cold period of the Northern States may have an added beneficial effect. The early varieties, Weymouth, June, and Cabot, begin to ripen during the latter part of May in Georgia and eastern North Carolina, the last of June in New Jersey, and not before the end of July in the Oswego section of New York. Other varieties ripen correspondingly later.

The highbush blueberry is native to swamps and moist soils, and unless ample soil moisture is available the plants may die in periods of low humidity. The hot, drying winds of summer in the Central States may prevent the successful culture of this blueberry in that area. Moreover, most of the prairie soils are not acid enough for the blueberry.

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[4] As the result of studies in New York, it is recommended that to acidify sandy soils ¾ pound of sulfur per 100 square feet be applied for each full point that the soil registers above pH 4.5 and that to acidify medium loams 1.5 to 2.25 pounds be applied for each full point above pH 4.5.

TABLE 2.—*Percentage of estimated 1940 acreage planted to each of 18 varieties originated by F. V. Coville, listed in order of their dates of naming or introduction*[1]

Name	Parentage	Year cross made	Year named or introduced	Estimated acreage (1940)	Characteristics responsible for introduction
				Percent	
Pioneer	Brooks × Sooy	1912	1920	11.0	Midseason; commercial.
Cabot	Brooks × Chatsworth	1913	1920	15.0	Early; commercial.
Katharine	Brooks × Sooy	1913	1920	0	High-flavored; noncommercial.
Greenfield	Brooks × Russell	1913	1926	0	Earliest; noncommercial.
Rancocas	(Brooks × Russell) × Rubel	1915	1926	12.0	Productive; commercial.
Jersey	Rubel × Grover	1916	1928	9.0	Late; commercial.
Concord	Brooks × Rubel	1916	1928	9.0	Productive; commercial.
Stanley	Katharine × Rubel	1921	1930	5.0	High-flavored; commercial.
June	(Brooks × Russell) × Rubel	1919	1930	2.5	Very early; commercial.
Scammell	(Brooks × Chatsworth) × Rubel	1915	1931	2.0	Productive; commercial.
Redskin	Brooks × Russell (F_2)	1913	1932	0	Red-colored; noncommercial.
Catawba	do	1913	1932	0	Catawba-grape color; noncommercial.
Wareham	Rubel × Harding	1915	1936	0	Very late; commercial.
Weymouth	June × Cabot	1928	1936	.5	Very early; commercial.
Dixi	(Jersey × Pioneer) × Stanley	1930	1936	0	Largest; commercial.
Atlantic	Jersey × Pioneer	1925	1939	.5	Large; late; commercial.
Burlington	Rubel × Pioneer	1916	1939	0	Very late; commercial.
Pemberton	Katharine × Rubel	1921	1939	.5	Very vigorous; large; late; commercial.

[1] About 30 percent of the estimated acreage was planted with Rubel, a variety selected from the wild by Miss E. C. White, and 3 percent with seedlings and other varieties.

VARIETIES AND THEIR CHARACTERISTICS

In 1906 the late F. V. Coville began experiments in the culture of the highbush blueberry. Selections were made in the wild, and breeding work was begun in 1909. Miss Elizabeth C. White, Whitesbog, N. J., made additional selections of wild plants and in cooperation with Coville established the first commercial plantings of hybrid blueberries. The breeding work has continued since 1909, and 18 selections have been named and propagated.

Formerly several selections from the wild (Rubel, Dunfee, Sooy, Harding, Sam, Grover, Adams, and Chatsworth) were grown commercially, but now only the Rubel of that group is considered of sufficient commercial value to be planted; many growers consider Atlantic, Pemberton, Jersey, Wareham, Burlington, and Dixi better varieties than Rubel and of about the same season. Breeding has produced berries about three times the size of the best wild blueberry. All varieties other than Rubel now being planted commercially are the result of the breeding work of Dr. Coville. All the commercial varieties are of pure highbush parentage except Rancocas and June, which are highbush backcrosses (Rubel × a selection from a lowbush-highbush cross), and Weymouth, which is a second backcross to the highbush (June × Cabot). Table 2 lists the varieties and gives an estimate of the relative acreage of each.

Varieties for Different Seasons

Cultivated plantings include about 15 varieties. Information on the merits of some of these is limited, but the discussion in this section and table 3 may give an idea of their relative qualities. As with many other fruits, climate and weather conditions affect the dessert quality and other characteristics of the fruit as well as of the plants. In gen-

FIGURE 13.—Cluster of flowers and buds at the end of a highbush blueberry branch. The flowers in any one cluster open over a period of several days, and the berries mature over a still longer period.

eral the berries are more highly flavored toward the northern limit of the blueberry areas, where the days are long and the nights cool when the berries ripen. However, if the days are sunny and the nights cool in more southern regions the flavor is much better than when the days are hot and cloudy and the nights warm. The varieties mature their berries over periods of 2 to 6 weeks (fig. 13). They are grouped as early, midseason, and late varieties.

Early Varieties

The Weymouth, June, and Cabot varieties are planted for early fruit. Cabot (fig. 14) matures over a long season, even requiring seven pickings some years. Although the berries may be large at the first picking, they are usually small, are poor in dessert quality except north of New Jersey, and crack badly in wet weather. The bush is very

TABLE 3.—*Highbush blueberry varieties ranked approximately in order of importance for certain growth, ripening, and other characteristics*

Rank	Season (early to late)	Size of berry (large to small)	Dessert quality (good to poorer)	Color (light to dark blue)	Shipping quality (good to poorer)	Cold resistance (hardy to tenderer)	Bush shape (erect to spreading)
1	Weymouth.	Dixi.	Stanley.	Stanley.	Jersey.	Wareham.	Rubel.
2	June.	Atlantic.	Wareham.	Jersey.	Burlington.	Jersey.	Rancocas.
3	Cabot.	Pemberton.	Pioneer.	Concord.	Rancocas.	Stanley.	June.
4	Rancocas.	Scammell.	Dixi.	Atlantic.	Atlantic.	June.	Scammell.
5	Stanley.	Jersey.	Atlantic.	Rubel.	Rubel.	Scammell.	Pemberton.
6	Concord.	Weymouth.	Concord.	Burlington.	Wareham.	Rubel.	Stanley.
7	Pioneer.	Concord.	Burlington.	Cabot.	Scammell.	Rancocas.	Jersey.
8	Scammell.[1]	Stanley.	Pemberton.	Rancocas.	Pioneer.	Cabot.	Concord.
9	Dixi.	Wareham.	Scammell.	Dixi.	June.	Concord.	Wareham.
10	Atlantic.	Pioneer.	Rancocas.	Pioneer.	Stanley.	Pioneer.	Burlington.
11	Pemberton.	June.	Rubel.	Scammell.	Pemberton.	[2]	Dixi.
12	Rubel.	Burlington.	Jersey.	June.	Cabot.	[2]	Weymouth.
13	Jersey.	Rancocas.	June.	Pemberton.	Concord.	[2]	Atlantic.
14	Wareham.	Cabot.	Weymouth.	Weymouth.	[2]	[2]	Pioneer.
15	Burlington.	Rubel.	Cabot.	Wareham.	[2]	[2]	Cabot.

[1] Scammell may ripen as late as Jersey.
[2] Both Dixi and Weymouth are too new for one to estimate either their shipping quality or cold resistance accurately; and little is yet known of the cold resistance of Atlantic, Burlington, and Pemberton.

subject to stem canker, stunt, and mite; therefore this variety is being discarded in North Carolina. June is earlier than Cabot and matures all its fruit in a short time. Though the berries are dark and not high in flavor, June is liked in New Jersey and North Carolina. Weymouth is even earlier than June, though blossoming later in some locations.

FIGURE 14.—Cabot bush, about 3 years old, with a good commercial crop of fruit and fine new growth. Ordinarily, unless large clusters of Cabot such as those shown are pruned back, the berries are not very large and insufficient new wood is produced for a full crop the following year.

FIGURE 15.—Clusters of blueberries: *A*, Pemberton; *B*, Rubel. These two varieties ripen at about the same season. Fruit of Pemberton average much larger than those of Rubel and the bush is more vigorous. Note that each cluster is made up of smaller clusters.

Its berries lack dessert quality and are dark, but Weymouth is extensively planted in North Carolina because of the earliness and size of the fruit and productiveness of the bush.

Midseason Varieties

Rancocas, Stanley, Concord, Pioneer, and Scammell are considered midseason varieties. Stanley and Pioneer are high-flavored. Rancocas is considered one of the most dependable varieties in New Jersey and North Carolina and is very resistant to stunt and stem canker, but its berries crack badly in wet weather and in Michigan it is subject to leaf drop. Stanley is liked because the bush is inexpensive to prune, but the berries in many fields become very small at the end of the season. Concord matures all its fruit quickly, but holds it on the bush a long time, is hard to pick, and does not keep well. (See cover for cluster of Concord.) Pioneer is unproductive in New Jersey and North Carolina, but productive in Michigan and New England. It is also very subject to stunt, stem canker, and mite in North Carolina and is being discarded except in Michigan and New England. Scammell has been liked in North Carolina because of its productiveness and resistance to stem canker, but is very subject to stunt. Though the bushes are productive and the fruit large in New Jersey, the fruit

is dark. If the clusters are not headed back, the fruit ripens with the late varieties.

Late Varieties

Dixi, Atlantic, Pemberton, Rubel, Jersey, Wareham, and Burlington are late varieties. The season of any of these may be extended about 2 weeks by light pruning and leaving a heavy crop on the bushes. Dixi, Atlantic, Pemberton (fig. 15, *A*), and Jersey bear the largest berries. Pemberton and Atlantic bushes are the most vigorous, though all of this group are vigorous. Dixi is new but has good quality and is promising. Atlantic is also new and is especially promising. Pemberton berries tear in picking more than those of most other varieties (fig. 16, *B* and *C*), but they are twice the size of those of Rubel and

FIGURE 16.—*A*, Berries of Burlington, showing small clean scars where the berries separated from the stems. *B* and *C*, Berries of Pemberton, showing tearing of the skin and flesh and large scars. Decay is much more likely to start at a large scar or where the skin is torn than at a small scar; hence, Burlington is considered a better shipping variety than is Pemberton.

the bush is much more vigorous. Jersey has very open clusters and a vigorous bush that is easy to prune. Wareham is hardy and productive, and its berries are high in dessert quality in Massachusetts, but they are too dark for growing elsewhere. Burlington berries have fine scars (fig. 16, *A*), a good blue color, and good flavor, but they are of only average size. Its bush is vigorous and easy to prune.

Varieties for Different Sections

In New Jersey, Weymouth or June for early season, Rancocas for midseason, and Dixi, Atlantic, Pemberton, or Jersey for late season are desirable. In North Carolina, Weymouth or June for early season and Rancocas for midseason are suggested. In Michigan and New

England, Pioneer and Rubel are standard sorts, but Jersey and Atlantic are promising late varieties. However, in Michigan, Weymouth, Stanley, and Jersey are good for early, midseason, and late seasons, respectively. In New England, Weymouth (early), Pioneer (midseason), and Jersey (late) are worth testing. Wareham ripens still later than Jersey and is worth while as the latest sort. In western Oregon and Washington, Pioneer, Stanley, and Jersey are known to succeed.

Varietal Descriptions

Adams.—Selection from wild. Bush vigorous, tall, open spreading, very productive; leaf dark green, medium-sized; berry small, dark blue, of fair dessert but poor keeping quality; scar poor; ripening just after Cabot, but, like Cabot, having a long season; best for upland soils; grown to a slight extent in Michigan. Bush vigorous and spreading; but fruit too dark, too small, and too tender for general commercial use.

Atlantic.—Jersey × Pioneer. Bush very vigorous, open spreading, very productive; leaf large; fruit cluster loose; berry very large, five-sided, oblate, of good blue color, firm, with slight aroma, above medium in dessert quality; scar one of best; season late, ripening about with Jersey. A late variety promising for large size, fine color, and good scar of fruit and for productiveness.

Brooks.—Selection from wild. Not grown now.

Burlington.—Rubel × Pioneer. Bush vigorous, upright spreading; leaf large; fruit cluster medium tight; berry medium-sized, round oblate, of good blue color, firm, with slight aroma, above medium in dessert quality; scar one of best; season late, about with Wareham, lasting about a week after Jersey and Rubel. Promising for its lateness, its fine blue color, and its fine scar superior to that of most other highbush varieties.

Cabot.—Brooks × Chatsworth. Bush below average in vigor, low spreading; leaf medium-sized; fruit cluster long, tight; berry small to medium-sized, oblate, of good blue color, not very firm, with slight aroma, of poor texture, usually below medium in dessert quality except in Michigan and the Northeast; scar fair; season early and long, first ripening usually just after Weymouth and June and last pickings with Jersey and Rubel; being discarded in North Carolina because very susceptible to stunt, stem canker, and mite and early flowering, exposing it to injury by late spring frosts; in the North susceptible to phomopsis gall but of better quality than in North Carolina and New Jersey.

Catawba.—F_2 of Brooks × Russell. Pink, partial albino; not grown now.

Chatsworth.—Selection from wild. Not grown now.

Concord.—Brooks × Rubel. Bush average in vigor, upright spreading, productive; leaf medium-sized; fruit cluster tight (see cover illustration); berry above medium-sized, oblate, of good blue color, firm, with very slight aroma, above medium in dessert quality; scar poor; midseason to late, suitable for leaving on bushes longer than most other varieties; usually picked after the Stanley and with Pioneer. Not grown extensively; though productive and large, not promising because of having bad scar and being expensive to prune.

Dixi.—(Jersey × Pioneer) × Stanley. Bush vigorous, open spreading, productive; leaf large; fruit cluster medium loose; berry very large, round oblate, of fair blue color, firm, aromatic, of good dessert quality; scar large; season late, slightly before Jersey. Promising for its large size, good dessert quality, and productiveness but with a poorer scar than Atlantic and Jersey.

Dunfee.—Selection from wild. Rarely grown.

Greenfield.—Brooks × Russell. Half-high; not grown now.

Grover.—Selection from wild. Rarely grown.

Harding.—Selection from wild. Rarely grown.

Jersey.—Rubel × Grover. Bush above average in vigor, erect, productive; leaf large, fruit cluster long and very loose, not at all tight; berry large, round oblate, of good blue color, firm, lacking aroma, of below to about medium in dessert quality; scar good; season late, with Rubel. Liked for its vigorous fine bush, great resistance to stem canker in North Carolina, open fruit cluster and large, late-ripening berry.

June.—(Brooks × Russell) × Rubel. Bush below average in vigor, erect; leaves medium-sized, subject to June spot and summer dropping; fruit cluster loose; berry medium-sized; round oblate, dark blue, firm, with slight aroma, medium dessert quality; scar medium; season very early, usually picked in

three pickings. Liked for its early ripening, but plants weakened by leaf drop following spot.

Katharine.—Brooks × Sooy. Not commercial because of bad tearing of skin and flesh at the stem end.

Pemberton.—Katharine × Rubel. Bush the most vigorous of all, erect, very productive; leaf very large; fruit cluster very loose; berry very large, round to round oblate, slightly darker than Jersey and Atlantic, firm, with slight aroma, medium to above in dessert quality; scar poor; season late, slightly before Jersey and Rubel. Liked because of its vigorous bush and large size of berry, which is dark and somewhat hard to pick.

Pioneer.—Brooks × Sooy. Bush open spreading, vigorous; leaf large; fruit cluster long and rather tight; berry medium-sized but large if heavily pruned; oblate, darker than Cabot, firm with characteristic aroma, of high dessert quality; scar medium-sized; season variable, midseason to nearly as late as Rubel. Liked in New England and Michigan because of its productiveness and good flavor, but being discarded in New Jersey and North Carolina because of its uncertain production and in North Carolina also because of its being very subject to stunt, stem canker, and mite.

Rancocas.—(Brooks × Russell) × Rubel. Bush erect, of medium vigor, productive; leaf small, serrate; fruit cluster very tight; berry medium-sized, oblate, fair blue, firm, crisp, with very slight aroma, medium in dessert quality; scar medium-sized; early midseason, just after Weymouth, June, and Cabot. Subject to June spot and drop in summer in Michigan, but liked except in Michigan for its dependable productiveness and its resistance to stem canker and stunt.

Redskin.—F_2 of Brooks × Russell. Reddish pink, partial albino; not grown now.

Rubel.—Selection from wild. Bush erect, vigorous, productive; leaf medium-sized; fruit cluster very loose; berry small to medium, oblate, of good blue color, firm, with slight aroma, medium in dessert quality; scar good; season late, with Jersey. Liked as a late variety for its productiveness and in North Carolina for its resistance to stem canker, but in many new plantings Dixi, Atlantic, Jersey, Pemberton, and Burlington substituted as late varieties.

Sam.—Selection from wild. Rarely grown.

Scammell.—(Brooks × Chatsworth) × Rubel. Bush erect, vigorous, productive; leaf very small; fruit cluster long and tight; berry large if properly pruned, oblate, dark blue, firm with very slight aroma, above medium in dessert quality; scar medium; season late midseason (after Stanley), unless clusters are pruned back a large part of berries ripening with Jersey. Liked in North Carolina for its productiveness and resistance to stem canker, but very subject to stunt and dark in color; not grown much elsewhere.

Stanley.—Katharine × Rubel. Bush erect, vigorous, but with few main branches; leaf very large; fruit cluster medium, loose; berry medium-sized; berries ripening last often very small, oblate, of good blue color, firm, very aromatic, of high dessert quality; scar medium-sized to above; midseason, ripening just after Rancocas. Though very aromatic the berries usually not very large, and later ones to ripen often very small; liked where berries are of good size.

Wareham.—Rubel × Harding. Bush upright spreading, vigorous; leaf small, serrate; fruit cluster medium loose; berry medium-sized, round oblate, dark blue, firm, with characteristic aroma, of high dessert quality; scar small; very late, lasting about a week later than Jersey and Rubel. Liked in Massachusetts for its regular cropping and high dessert quality; not grown elsewhere because of dark color.

Weymouth.—June × Cabot. Bush erect, open spreading, of average vigor; leaf of above average size; fruit cluster medium loose; fruit of above medium size, round oblate, dark blue, firm, lacking aroma, usually of poor dessert quality; scar medium; earliest of all, ripening all berries quickly. Planted extensively for early season, but dark and not of good quality.

NEED FOR CROSS-POLLINATION

Results of experiments indicate that it is essential at least under some conditions to grow two varieties of blueberries near each other for cross-pollination. The early experiments of Coville led him to state[5] that "When blueberry flowers are pollinated with pollen from

[5] See Dept. Bul. 974, p. 17.

their own bush the berries are fewer, smaller, and later in maturing than when pollen comes from another bush [from a bush of another variety]." Experiments in North Carolina, New Jersey, and Massachusetts have, in general, confirmed Coville's results. However, growers in Michigan have set solid blocks to a single variety, and the heavy crops of large-sized berries of Rubel grown in solid blocks indicate that so far the practice has been satisfactory there.

GROWING AND CARE OF SEEDLINGS AND NATIVE PLANTS

Because the cultivation of the blueberry is a relatively new industry and most of the cultivated varieties are the result of breeding and have been introduced recently, many practices are being tested that would not be followed in an older industry. Several large fields of seedlings are still bearing fruit in New Jersey, Michigan, and Washington. Though they may produce good crops, the berries are relatively ununiform in season, size, color, and flavor and are less desirable for the general market than are berries of cultivated varieties. Some fields of bushes selected from the wild are also still being picked, but the fruit is much smaller and even less desirable than that of seedlings of varieties. Many areas of native bushes are being given some attention; the competing trees and bushes are being removed, the blueberries fertilized, and the bushes pruned. Where the stand of blueberries has been good this care has sometimes been profitable. Such berries, however, have to compete with fruit from cultivated plantings of selected varieties.

PROPAGATION

The blueberry is not so easy to propagate as are many other plants, but with careful attention it is propagated extensively by either hardwood or softwood cuttings. The hardwood cuttings, 4 to 6 inches long, are made from dormant shoots of the previous season's growth, the lower cut being made just below a bud and the upper just above one (fig. 17, *A*). Wood with fruit buds should be cut off and discarded, as but few cuttings with fruit buds root or make good plants. The cuttings are rooted either in ground beds with lath shade about 7½ feet above the ground or in covered frames. Ground beds are those made directly on the ground; they are usually filled with a mixture of half peat and half sand to a depth of about 6 inches. The most commonly used covered frames are 6 feet by 27 inches by 16 to 40 inches and contain trays 4 inches deep with the bottom made of ⅛- to ¼-inch-mesh hardware cloth or fly screen. The trays rest on cleats 8 to 10 inches below the top of the frame. The trays are filled with peat, and the cuttings are placed about 1 inch apart in rows 2 inches apart and in a slanting position. An advantage of the tray is that it can be removed to a coldframe or to the nursery row, while cuttings in the ground bed require transplanting. In Michigan each frame is covered with a sash and then with coarse burlap, while in New Jersey either slat or lath covers are used for shade.

Cuttings are made while the plants are dormant. They may be stored in a cool moist place until they can be placed in the propagating beds early in the spring. Usually they have rooted by June (fig. 17, *C*), but are left in the ground beds or, if propagated in covered frames, are placed in coldframes until the following spring.

FIGURE 17.—*A*, Hardwood cuttings with fruit buds at tip; these should be cut off as indicated. *B*, Cutting with a shoot at the upper end and a good callus but no roots at the base. Roots should appear within a few days. *C*, Well-rooted cutting.

Softwood cuttings are made when secondary growth first appears on the new shoots. They are made about 4 inches long, and only the two upper leaves are left on the cutting. The upper half of each of the two leaves is usually cut off to reduce transpiration. In Michigan softwood cuttings are handled in frames as are the hardwood cuttings; in New Jersey they are propagated under glass, but softwood cuttings are little used commercially.

Both hardwood and softwood cuttings are usually grown for a year in the nursery row before being planted in the fields. The nursery rows are usually 18 inches apart and the plants 6 to 10 inches apart in the row. After a year in the nursery row they are called 2-year plants. Well-grown 2-year plants are considered most desirable for field planting.

Rancocas, Rubel, and Pemberton are relatively easy to root from cuttings; Jersey, Pioneer, Concord, and Scammell are somewhat less so; and June, Atlantic, and Stanley are more difficult.

PLANTING AND CULTIVATION

The plants are usually set 4 by 8 feet, 4 by 10, 5 by 8, or 6 by 8 as early in the spring as the soil becomes suitable for working. Setting them 5 by 8 feet (1,089 plants per acre) is suggested for new plantings. Setting 4 by 10 feet (1,089 plants per acre) is suggested for plantings for standard tractor cultivation. In New Jersey some early-fall planting is done; in eastern North Carolina planting is done in the late fall or winter. The blueberry is shallow-rooted; therefore cultivation should be shallow. Clean cultivation has been the usual practice, but because of danger of erosion and of soil impoverishment it is not advisable as a permanent practice. In Michigan a spring oat cover crop sown just after the harvest is recommended. Ground covers of lespedeza and annual bluegrass and mulches are being tested in New Jersey.

MAINTAINING SOIL FERTILITY

The essential requirements for successful blueberry culture are that the plants be vigorous and that they produce good crops each year. On fertile soils very little fertilizer may be required, while on poor soils larger amounts may be necessary to maintain satisfactory growth. Stable manure should not be used except as careful trials have shown it safe to use. It has often been very injurious, even though light applications to some of the more acid soils have been beneficial. In Michigan the application of superphosphate alone up to 670 pounds per acre has given good results, but about 500 pounds of a complete fertilizer has generally been somewhat better. In localities where blueberries are now planted in New Jersey and North Carolina, nitrogen has seemed most often the limiting element. For locations where satisfactory practices are still unknown, it is suggested that one application, 400 to 600 pounds per acre, of a complete fertilizer (about 5–10–5) be made in the spring at the time the buds are starting. This should be followed about 6 weeks later, if the soil is very acid (below pH 4.8), by an application of 150 pounds of nitrate of soda or of calcium nitrate per acre; or, if the soil is not very acid (above pH 4.8), by an equivalent amount of nitrogen in the form of sulfate of ammonia (110 pounds per acre), followed by one or possibly two similar applications at intervals of 6 weeks. The more fertile fields should not have the later fertilizer applications. The fertilizer should be broadcast to within 6 to 12 inches of the plant and out as far as the roots extend.

If the foliage shows chlorosis or yellowing, ammonium sulfate should always be used instead of nitrate of soda as a source of nitrogen; and the plants should turn green within a few weeks. For blueberries on loam, sulfur may be used in place of sulfate of ammonia (p. 15).

IRRIGATION AND DRAINAGE

As the highbush blueberry is a native of swamp and moist lands where the soil moisture is ample throughout the season, cultivated fields should also have ample moisture; but they should also be well drained with the water table about 18 inches below the surface. However, in periods of low rainfall the water table may drop so low that the plants and crop may suffer severely. Very careful consideration of the soil-moisture conditions should be made before the bushes are planted. Mulching (p. 26) with sawdust or other materials helps to conserve moisture.

Because of severe droughts in North Carolina, in recent years much of the acreage there has been provided with irrigation, part with gravity flow and part with a sprinkling system. Because of the relatively long season of ripening of the blueberry two or three applications of 1 to 2 acre-inches of water about 10 days apart during the picking season may be needed. Fields there may also need some irrigation later in the season during the hot weather of summer.

Where soil and other conditions are favorable and a blueberry field can be expected to receive some spring or sidehill seepage water almost continuously, it is often possible to construct the drainage so that the water table can be maintained practically continuously at the desired level. Under ideal conditions excess water can be quickly removed during or after storm periods and yet the water table can be maintained at the desired level; relatively inexpensive structures can insure both excellent drainage and effective irrigation at small cost.

MULCHING

Mulching with leaves, sawdust, hay, or straw was suggested for home garden plots of blueberries (p. 11). Such mulching has been used commercially on small areas in New England, New Jersey, North Carolina, and northern Georgia with success. Mulching materials applied to the depth of several inches keep down weeds, keep the soil cooler in summer, help to retain soil moisture, and help to control erosion. The plant rows may be covered for 2 to 2½ feet on each side, or the entire area may be mulched. Leguminous hay mulches (clover, soybean, etc.) have sometimes been injurious and should not be used unless thorough trial has shown no injury over a period of a year or more. When leaves, sawdust, hay, or straw is used, additional nitrogen must be applied to obtain good growth. Instead of using the 110 pounds of ammonium sulfate per acre required where mulches are not applied, two or three applications, each of 300 pounds per acre, should be used on mulched areas at 6-week intervals. For small plantings one-third to one-half pound per bush should be scattered over the surface at each application, not closer than 6 to 8 inches to the base of the plant.

PRUNING

The blueberry produces fruit on wood of the previous season's growth. The largest fruit is borne on the most vigorous wood. Most varieties tend to overbear, and unless part of the buds of such varieties are pruned off the berries are relatively small and there is too little vigorous new growth for the next year's crop. The erect-growing varieties, such as Rubel, Rancocas, Scammell, June, and Concord, need to be thinned at the center, whereas Cabot and Pioneer are especially spreading and are likely to need pruning of the lower drooping branches.

Heavy pruning (thinning the small branches, heading back clusters, and cutting out some old stems) reduces the crop greatly and hastens ripening. It should rarely be practiced. Light pruning (thinning out some of the small branches and an occasional stem), though it reduces the crop for a particular year, increases the size and earliness of the berries and tends to produce more vigorous new growth for the next year's crop than does no pruning. The heavier the pruning the larger the berry size, the earlier the ripening, and the smaller the total

TABLE 4.—*Yield per plant and size of berries from full-grown bushes of the Rubel and Pioneer blueberries under different types of pruning at South Haven, Mich., 1939 and 1940*

[1 pound=1.14 pints]

Type of pruning	Berries per plant				Berries per half-pint cup			
	Rubel		Pioneer		Rubel		Pioneer	
	1939	1940	1939	1940	1939	1940	1939	1940
	Pounds	*Pounds*	*Pounds*	*Pounds*	*Number*	*Number*	*Number*	*Number*
None	23.4	20.1	25.3	26.9	222	181	190	132
Light	17.3	19.9	18.4	18.8	189	204	173	136
Medium	16.3	14.3	17.4	11.0	174	192	151	130
Heavy	7.6	8.1			164	169		
Very heavy	3.9	9.1	5.8	10.8	145	145	85	99

crop for that year. Under some conditions where the crop is heavy and no pruning is done, most of the berries may not mature.

Tests in Michigan of different methods of pruning (table 4) illustrate the effect of pruning for 2 years on yield per plant and size of berries. With Rubel, very heavy pruning as compared with light pruning reduced the crop more than 75 percent the first year and more than 50 percent the second year. On the other hand, it increased the size of the berries by about 25 percent the first year and by about 30 percent the second year. Similar decreases in yield and increases in size following very heavy pruning occurred with the Pioneer variety.

Pruning also had an important effect on the time of ripening. With heavy pruning in Michigan in 1939, 93 percent of the crop from heavily pruned Rubel bushes was harvested at the first picking; whereas with light and medium pruning only 63 and 65 percent of the crop, respectively, was harvested at that picking. With the Pioneer, 92 percent of the crop on heavily pruned bushes was picked at the first three pickings (within 2 weeks), but on lightly pruned bushes only 54 percent ripened in the same period and the other 46 percent ripened over a 4- to 5-week period. Thus, it is possible to shift the ripening period by the amount of pruning done. In North Carolina and other Southern States relatively heavy pruning may be practiced to obtain an early maturing crop, while in the Northern States the practice of light pruning may spread the ripening season over several weeks.

Less pruning is necessary on very vigorous plants. If the plants are heavily fertilized and the soil-moisture supply is adequate at all times, the plants make much stronger growth and can produce a much heavier crop of large berries than if fertility is lacking and the soil-moisture supply is insufficient at times.

Usually very little pruning is necessary until the end of the third season, when regular annual pruning should ordinarily begin. The general practice is as follows: (1) The low spreading branches next to the ground should be cut out, leaving only the erect branches or shoots. (2) If the center of the bush is dense, the weak and the older branches at the center should be cut out. (3) Most of the small slender branches should be removed, leaving the strong branches and shoots (fig. 18). Many of these small branches are thickly set with fruit buds, while sometimes nearly all these slender branches have no fruit buds. These weaker branches cause the bush to become too dense, thus making

FIGURE 18.—Four-year-old blueberry bush of the June variety: *A*, Before pruning; *B*, after pruning. Pruning reduced the fruit buds by about 75 percent. In very fertile soils a large number of fruit buds might be left for a heavier crop.

picking difficult and leaving inadequate space for strong new shoots. Rubel, Concord, and Rancocas bushes require much thinning out of the small branches and are, therefore, expensive to prune. Finally, in order to increase the size of the berries the fruiting shoots of some varieties should be cut back, the amount depending on the number of fruit buds on such shoots. June, Weymouth, Rancocas, Concord, Stanley, Jersey, and Rubel require very little cutting back; Cabot, Scammell, and Pioneer require cutting back to about three to five fruit buds per shoot. The amount of necessary cutting back varies from year to year, depending on growing conditions. Cutting back is usually done after danger of cold injury is past. General pruning may be done at any time from leaf fall in the autumn to the beginning of growth in the spring.

HARVESTING AND MARKETING

The first berries from the early varieties are picked about May 20 in North Carolina, June 20 in New Jersey, and July 10 in southern Michigan. From three to seven pickings are made at 5- to 7-day intervals. In any one locality the season usually lasts 6 to 7 weeks. To provide the best possible supply to markets, the North Carolina growers are mainly interested in early to midseason varieties, the New Jersey growers in midseason and late ones, and the Michigan growers in very late sorts. In 8 hours pickers can harvest 60 to 80 pints or even more where the crop is heavy. Pint baskets are used mostly as containers, but these have to be made tighter than for larger fruits such as strawberries. Most of the crop in the three States mentioned is marketed cooperatively. The berries are sold according to size grades, the larger berries usually bringing a higher price than the smaller ones. Early and late in the season small berries sometimes bring higher returns than larger berries in midseason.

YIELDS

Records of yields vary greatly. In Michigan on good soil the yields from the second to the sixth year were 50, 200, 2,050, 4,000, and 6,000 pints per acre, respectively. Larger yields are possible, and as many as 9,600 pints per acre have been obtained from good fields. Full production is reached in 6 to 10 years, but it may be reached earlier with good culture. Individual bushes should produce a little fruit after being planted 1 year. When mature, they usually bear 6 to 8 pints per plant, and with medium pruning they may produce 12 to 20 pints per plant (table 4).

USES

Though most of the crop from cultivated fields is marketed in the fresh state, large quantities of the highbush blueberry are canned or frozen. Because the canned berries are largely used for pies they are packed mostly in water and to a lesser extent in a sugar sirup. The frozen berries also are used mostly for pies and are frozen with or without sugar or sirup. Recently quantities have also been frozen in small containers for table use. Both before and after freezing, Pioneer, Cabot, and Concord were better in flavor than Rubel and Rancocas. The frozen product was nearly equal to fresh fruit in appearance and quality. The frozen pack in 50-percent sirup was considered preferable to that in either 40- or 60-percent sirup and was much superior to packs where dry or no sugar had been used. The frozen berries were also superior to canned ones. Blueberry juice has been produced commercially to a limited extent.

BLUEBERRY DISEASES

STUNT

Stunt is a virus disease, at present known to occur in damaging amounts in fields of highbush blueberries in New Jersey and North Carolina and to a lesser extent in New York and Michigan. So far more plants of Cabot, Pioneer, Concord, and Scammell than of other varieties have had the disease. No variety is known to be immune, but the disease has not been positively identified on Rancocas and some other varieties. Rancocas is highly resistant, at least. The disease most frequently appears in individual bushes scattered through a field and in adjacent bushes in a row, but it has destroyed some entire fields. It can be transmitted by buds and grafts or by cuttings, but the manner of natural spread is unknown.

The general effects of stunt are dwarfing of bushes, reduction in the size of leaves, and yellowing of leaves during summer, followed by brilliant reddening during late summer and early fall. The berries produced are small, have an unpleasant flavor when ripe, and stick tightly to the stem.

Basal shoots of affected bushes rarely reach a height of 3 feet, but more often in advanced stages of the disease they do not exceed 1 foot. On such shoots the upper leaves are small, often short in comparison with the normal length, and sometimes cupped. Leaves of affected plants are pale, with greenish-yellow tips; the pallor extends from the tips halfway or more towards the base.

During early summer, symptoms of the disease may be inconspicuous, except shortening of branches and some slight yellowing of shoot leaves on fruiting branches. In late summer or early fall, however, the leaves of most varieties change from the normal green to a brilliant orange red. In contrast with the reddening of the leaves that may result from such other causes as deficiency of nitrogen, iron, or magnesium in the soil, flooding or lack of drainage, or severe heading back, the reddening caused by stunt appears first on the margins and not at the tips or bases. In advanced stages the margin may become brown, the red color occurs in two parallel stripes, and the area around the midrib may remain green.

Unless a field is so generally infected as to make roguing impractical, bushes affected with stunt should be taken out as soon as found, in order to prevent possible further spread of the disease. When a diseased bush has been removed, it is thought safe to fill the vacancy with a healthy plant.

There is no indication that the infective agent of the disease can be transmitted from a diseased bush to a healthy one by means of tools used in pruning or cultivating. It can, however, be transmitted in buds or grafts from affected bushes.

MUMMY BERRY

Mummy berry, caused by the fungus *Sclerotinia vaccinii* Wor., has been a serious disease on the highbush blueberry in some years in New Jersey and other northern blueberry sections, and on the rabbiteye blueberry as far south as southern Mississippi. It is erratic in its occurrence. It may almost disappear for a few years and then quickly build up to epidemic proportions when spring weather conditions are favorable for spore production and infection.

The fungus causes blighting of the new shoot tips and blossoms and destruction of the berries. Wilting and killing of the shoot tips and blossoms are first noticed in moist weather in early spring (late March through April in New Jersey), and the visible effect is not unlike frost injury. The wilted tips and blighted blossoms produce spores, which later infect the very young fruits. The infected fruits develop to almost full size before their growth is stopped. When normal berries are still green, the infected ones, commonly called mummy berries, turn cream or tan and shatter easily (fig. 19).

FIGURE 19.—*A*, Cluster of highbush blueberries of which five are affected by mummy berry; *B*, affected berries, which commonly drop before ripening.

Within these fallen mummy berries are formed hard fungus structures (sclerotia), frequently the size and shape of the berries, black on the outside and whitish within. These bodies may remain dormant on or near the soil surface for several years; but ordinarily, if weather conditions the following spring are favorable, each may produce one to several small, stalked, toadstoollike structures (apothecia). Inside these are formed numerous spores capable of starting the disease anew on the young shoots and blossoms.

A large number of berries may become infected and fall to the ground, but the most serious damage is the killing of blossoms, fruit clusters, and young shoots. The berries of some varieties, particularly Jersey and Rubel, are very susceptible to infection. Blighting of shoot tips of the Adams variety and of blossom clusters of the Cabot is sometimes serious.

Control

Spraying has been ineffective against the mummy berry disease. In small plantings the practice of daily removal of all wilted shoots before spores are produced has given fair control.

The control method most common in New Jersey consists in sweeping or raking the soil surface under the bushes and frequent tillage between the rows during early spring when the spore-producing structures have started to form and before they have discharged their spores. The object of sweeping and tillage is to disturb the overwintered mummies at a critical period, thus stopping further apothecial development. An application of calcium cyanamid to the soil at the rate of 150 pounds or more per acre at the time of sweeping also seems to have been effective in rendering the mummies incapable of producing the spore-producing structures.

PHOMOPSIS TWIG BLIGHT

On both highbush and rabbiteye blueberries a distinct blight of twigs, of the tips of shoots, and sometimes of entire shoots is caused by *Phomopsis vaccinii* Shear, a fungus that is also parasitic on the cranberry. No cultivated variety of the highbush blueberry is known to be resistant. The disease occurs in New Jersey, Massachusetts, North Carolina, and Washington, and probably in other sections. It is usually not serious but has done considerable damage in areas where water stands for any length of time during the growing season and has become rather severe after abnormally heavy rains, which have resulted in the flooding of fields.

The fungus enters the tip of a fast-growing shoot and progresses toward the base. Its advance is rapid in succulent tissues; the tip wilts and turns dark brown or black within a few days, with a sharp line of demarcation separating it from the healthy, light-green bark below. However, some of the leaves may drop from the apparently healthy part of the shoot and, if the shoot is split, a slightly discolored zone of underlying tissue may be found extending downward several inches beyond the darkened bark area, and even below this zone the pith shows a brownish color and is divided transversely into sections. When the fungus reaches the base of a succulent shoot it enters the older wood, in which it progresses much more slowly. As soon as the older wood is girdled, the parts above the girdle die.

The fungus lives over winter in blighted wood and produces numerous spores in the spring. Because these spores require moist conditions for germination, a prolonged period of dry weather in the spring may greatly reduce the number of new infections.

Control

Dormant pruning should include the removal of all blighted or discolored wood. Branches apparently winter-killed should be regarded with suspicion. Prunings should be carefully collected and burned before growth starts. When blighted tips are discovered during the summer, the new infections can frequently be removed before the fungus reaches the old wood, by cutting the shoot back to a point where the pith appears normal. After a badly infected field has been pruned, a delayed dormant application of lime-sulfur (1 part of commercial lime-sulfur solution to 9 parts of water), followed 2 or 3 weeks later by a spray of 4 4 50 bordeaux mixture with rosin-fish-oil soap, helps to prevent new infections.

FIGURE 20.—Blueberry stem canker. *A*, Infections as they appear at the beginning of the second season. Note cracking of some swellings. One and one-half times natural size. *B*, Canker around point of infection, at end of second season. One and one-fourth times natural size. *C*, Blisterlike swellings, such as are shown in *A*, during the third season. About natural size. *D*, Old and deeply cracked canker that has girdled the stem. Parts above such cankers usually die. About one and one-half times natural size.

STEM CANKER

A fungus disease of blueberry, caused by *Physalospora corticis* Demaree and Wilcox and known as stem canker, is of considerable economic importance in the South. The fungus causes extensive cankers and blisters on the more susceptible varieties. Some cultivated varieties of the highbush blueberry are so seriously injured that they cannot be grown profitably. Cabot and Pioneer are probably

the most susceptible highbush varieties, followed by Concord, June, and Stanley; Rancocas, Jersey, and Scammell are highly resistant, and Rubel is still more resistant. The disease is also prevalent on both the wild and cultivated rabbiteye blueberries of Mississippi, Alabama, and west Florida. Only Locke, of the named varieties of the rabbiteye blueberry, has been found affected.

The disease becomes established in new shoots. It is inconspicuous at first but gradually spreads year after year, finally forming large, blackish, roughened cankers, more or less swollen, or grayish areas, only slightly swollen, with uneven bark surface (fig. 20). The disease is spread by spores that develop in tiny, black receptacles on the surface of the cankers.

The injury is due to the girdling of the branches and stems, caused by the presence of the fungus in the infected bark; the girdling results in the death or weakening of that part of the stem above the cankered areas.

Control

Attempts to control the disease by spraying, pruning out the cankered branches, or even removing the entire bush when badly infected have not so far proved to be of much value. It has been observed that when a badly diseased bush is removed and the space is reset with a new plant of the same variety, or one equally susceptible, the latter soon becomes infected and shows evidence of injury and lack of productivity in about 3 or 4 years, or soon after its normal age for profitable fruit production. Therefore, the only practice known to reduce the loss occasioned by the canker disease in fields where it is serious is to remove all plants of any very susceptible varieties and reset with resistant ones. Though this may not eradicate the disease, the resistant varieties have not been sufficiently injured so far to result in any apparent reduction of the crop.

In the South, blueberry growers who contemplate enlarging their plantings or who plan to start a new field should select only those varieties known to be resistant to the disease; at least they should limit the use of Cabot and Pioneer, the most susceptible of all varieties. It is further recommended that they obtain plants or propagating wood from a region or field where it is known that stem canker is not present. The precaution of using disease-free plants does not, however, give complete assurance that the disease will not later appear, since wild blueberry bushes in nearby swamps or forests may have the disease, and it can be spread from these to the new planting.

POWDERY MILDEW

Powdery mildew, caused by the fungus *Microsphaera alni* DC. ex. Wint., is common in all regions on the highbush blueberry, appearing in late summer. It is most abundant in dry seasons and is rarely of much economic importance; special control measures do not seem to be warranted. Pioneer and Cabot are among the most susceptible varieties.

DOUBLE SPOT

A serious fungus leaf spot of undetermined cause and commonly known as double spot is found in nearly all highbush blueberry fields in North Carolina. The spots first appear in May or June, gradually increase in number throughout the summer, and in some years cause considerable defoliation. The spots are more or less circular and range from one-sixteenth to three-eighth of an inch in diameter. At first the spots are tan and are surrounded by a narrow purplish ring. Some of the spots remain this way; after midsummer others are greatly enlarged by the formation of a wide band of light to cinnamon brown around the central or original small spot (fig. 21). This character suggested the name "double spot," now in common usage.

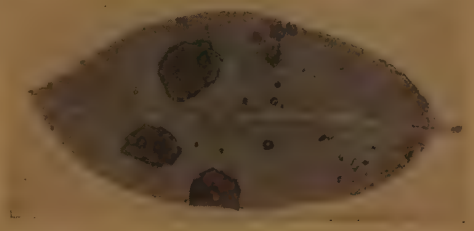

FIGURE 21.—Double spot, a serious leaf disease of the cultivated highbush blueberry in the South.

Control

Spraying with 4–4–50 bordeaux mixture has given very satisfactory control in commercial fields. Where the disease is serious three applications are recommended: the first soon after the blossoming period, the second immediately after harvest, and a third about 30 days after the second application.

There is some difference in the resistance of varieties to double spot. Cabot, Dixi, Jersey, Pioneer, and Rancocas are among the most susceptible; Concord, Grover, Harding, June, Sam, Stanley, Rubel, and Weymouth have shown some resistance.

BLUEBERRY INSECTS

Almost 300 species of insects attacking the blueberry have been listed. Only the most important that have appeared in cultivated fields are discussed here.

BLUEBERRY MAGGOT

The most serious pest of blueberries is the blueberry maggot (*Rhagoletis pomonella* (Walsh)), also known as the blueberry fruitfly, the apple maggot, or the railroad worm. It feeds on blueberries, and the presence of a few infested berries may cause an entire shipment to be condemned as unmarketable. The adult (fig. 22) is somewhat similar to a housefly in shape, about three-sixteenths of an inch long, with a brown face, shining black eyes and body, white on the sides and rear of the thorax, a white band at the rear of each abdominal segment, and some characteristic white patches on the wings. In New Jersey the flies emerge from overwintering puparia between June 15 and July 15, chiefly from June 20 to July 5. In Maine they emerge 20 days later. After flying about for 10 to 12 days, they begin to lay eggs in the ripe or ripening fruit. The eggs hatch in from 2 to 5 days, and the larvae mature in about 20 days, when they enter the ground, pupate, and remain dormant until the next or some subsequent year. This insect has not caused serious injury in Michigan and North Carolina, but it is present in the wild as well as in cultivated fields of New England and Pennsylvania.

Control

The adult flies can be killed by dusting the field with ground derris (5 percent rotenone), 10 to 15 pounds to the acre, when the flies first appear in numbers but before egg laying has started, with a second application 10 days later. Usually the derris dust is applied by aircraft in the larger plantings. If a hand machine is used, enough diluent should be added to get sufficient distribution. In Maine calcium arsenate dust at the rate of 6 pounds to the acre at each application is used instead of derris.

An interval of 2 weeks should follow the last application of the calcium arsenate before the berries are picked. **(See also page 35.)**

CRANBERRY AND OTHER FRUITWORMS

The blueberry fruit is attacked by the cranberry fruitworm (*Mincola vaccinii* (Riley)). The moths from overwintering cocoons fly in from nearby untilled land as early as May 20 in New Jersey. Eggs are laid on the blueberries after this time. A newly hatched worm enters a blueberry at the stem end and eats the seeds and some pulp. Then it leaves this berry and enters another, usually one that touches it in the cluster. It destroys or injures one or two more berries in the cluster before attaining full size. The smaller berries dry up, but some of the larger ones retain their shape and show the injury only by a slight malformation and premature coloring. The early varieties are most seriously injured by this pest. The fruit damage, however, is relatively unimportant as compared with the loss

FIGURE 22.—An adult blueberry fruitfly.

occasioned by the worms leaving the harvested fruit after it is packed and crawling over the top of berries under the cellophane cover, thus giving the fruit a dirty appearance in the market.

The cherry fruitworm (*Grapholitha packardi* Zell.) and the plum curculio (*Conotrachelus nenuphar* (Hbst.)) also infest blueberries occasionally.

Control

Pyrethrum dust applied by airplane at the rate of 30 pounds per acre, once on May 29 and again a week later, is effective in controlling cranberry fruitworm in New Jersey.

CRANBERRY WEEVIL

The cranberry weevil (*Anthonomus musculus* Say), also known as the blueberry weevil, is distributed over the eastern part of the United States. The adult is about three thirty-seconds of an inch long and has a slightly curved snout about one-third as long as the rest of the body. The wing covers are ornamented lengthwise with rows of little pits. Narrow white scales, noticeable under a magnifying glass, are scattered over the legs and body and often form transverse patches on the wing covers. The general color is dark brown or black, and the abdomen and legs have a reddish cast.

There is one generation a year. The weevils pass the fall and winter hiding under the trash or in other places of concealment, resuming activity as the weather warms in the spring. The use of a permanent mulch in the field offers excellent winter quarters for the weevils, but clean cultivation forces them to hibernate outside the field. The damage they do is of two kinds. When the early leaf and fruit buds start to swell, the beetles bore into some of them from the side and consume most of the contents. Most buds so injured do not open at all, and the few that do, form a small rosette of malformed leaves. The weevils mate soon after hibernation. As the blossoms show white, egg laying begins. A female will puncture the corolla and lay a single egg in a flower, usually among the anthers. The grub hatches in a day or two and eats the stamens, pistil, and part of the ovary, leaving a mere shell. The flower does not open. The grub pupates inside the shell of the flower. This pest reduces the crop over 50 percent in many places.

Control

If the weevils occur in but a narrow strip along the edge of a field, the injury can be reduced greatly by dusting with pyrethrum whenever the insects appear in numbers. Repeated applications must be made during the short period between the swelling of the buds and the opening of the flowers. To protect an entire field, spray with arsenate of lead (3 pounds to 50 gallons) when the fruit buds swell, being sure to cover all leaf and fruit buds well.

As lead arsenate is a poison, it should be stored where children and animals cannot gain access to it. The face should be protected while the chemical is being handled, mixed, and applied.

BLUEBERRY BUDWORM

As the fruit buds swell in spring, they are sometimes eaten by cutworms of various kinds, especially the blueberry budworm (*Rhyncagrotis anchocelioides* (Gn.)). Elimination of leaves and trash on the field helps to keep down the infestation, and poison bran mash may be used to kill many of the insects. Leaves do not ordinarily accumulate if clean cultivation is practiced.

FOREST TENT CATERPILLAR

Occasionally blueberry fields are defoliated by the migrating larvae of the forest tent caterpillar (*Malacosoma disstria* Hbn.). The use of ditches or other mechanical means of stopping such migrations are the best means of control. Knocking the worms off the bushes into a pail is also effective but somewhat slow.

FALL WEBWORM

A common unsightly pest in the blueberry fields is the so-called fall webworm (*Hyphantria cunea* (Drury)). It actually occurs in both spring and fall. A colony makes a web at the end of a twig enclosing some foliage, which is its first food. After all these leaves are eaten the entire colony moves to another limb, spins a new web, and repeats the feeding process. It is easy to find the webs and remove them by hand and then destroy the worms.

DATANA WORM

One of the most obvious leaf-feeding worms is the datana worm (*Datana angusii* G. and R.). It usually feeds in colonies of about a hundred individuals, a large enough group to defoliate a bush entirely if not removed. When disturbed, it has a peculiar habit of raising its head and anal segments as though assuming a fighting position. It is only a bluff, however, and the worm is harmless to everything except leaves. It can be identified by its dark head, yellow "neck," and longitudinal yellow stripes which extend along its body.

Control

The most effective control measure is to remove the young colonies by hand. Arsenical insecticides are impractical because of the presence of ripe fruit at the time the insect is feeding.

LEAF ROLLERS

Four species of leaf rollers are common on blueberries. They are held in check by parasites and by the treatments suggested for fruitworm and fruitfly.

BLUEBERRY MITE

Some of the older fields of North Carolina and New Jersey are infested with blueberry mite (*Eriophyes vaccinii* Keifer). These mites are too small to be seen with the naked eye, being about one one-hundred-twenty-eighth of an inch long. During the dormant season 50 or more of them may often be present between the scales of a single bud. The buds may be destroyed before they open, the flowers may be distorted and not set, or the berries may develop abnormally. The entire crop may be destroyed, but severe damage is sporadic, being serious in some years but not in others. The mites are often accompanied by thrips, which are large enough to be seen and are likely to be blamed for the injury. Red, blistered, misshapen flowers and red, warty, misshapen berries are the first obvious signs of injury (fig. 23). No spray application has yet been successful as a control measure. The damage is most serious on Cabot, Rancocas, June, and Scammell; Pioneer is somewhat less susceptible; Concord is rather resistant; and Rubel and Burlington are very resistant.

SCALE INSECTS

Blueberry bushes are often infested with scale insects, the most common of which is Putnam scale (*Aspidiotus ancylus* (Putn.). It occurs in most of the older fields and causes considerable injury. Bushes that are not pruned regularly to remove the old wood are more heavily infested than others. The scale infests chiefly rough wood, where hundreds of individuals occur in the protected spots, often with one scale overlapping another. Such spots may be injured to such an extent as to deform the stem. The scale occurs singly on the new twigs, on the leaves, and sometimes on the fruit. On the fruit it appears as a gray or black spot about one-sixteenth of an inch in diameter. The part under and around the scale does not grow as fast as is normal and so produces a flat or dented area in the berry.

Other scales are more obvious but do not do serious damage. Among them are oystershell scale (*Lepidosaphes ulmi* (L.)) and terrapin scale (*Lecanium nigrofasciatum* Perg.).

FIGURE 23.—Blueberry mite injury: *A*, Infested branch with part of buds destroyed but the rest developing normal berries; *B*, infested branch with abnormal or injured berries and destroyed buds; *C*, branch on which all buds have been destroyed. The roughening of the surface of buds or berries is characteristic of mite injury.

Control

Putnam scale can be controlled effectively with a dormant spray of winter-strength lime-sulfur (1 gallon to 8 gallons of water). Old stems with rough bark should be thoroughly wetted. Some growers consider the pest of sufficient importance to require regular control measures, and as the bushes grow older such measures will probably become increasingly necessary.

STEM GALL

The common insect gall on blueberries is caused by a chalcid fly (*Hemadas nubilipennis* (Ashm.)). It may become numerous enough to reduce the fruitfulness of the bush if allowed to reproduce undisturbed. As many as 200 galls have been counted on a single bush.

Control

However, the control is simple. The galls should be cut from the bushes, removed from the field, and destroyed during the winter pruning. The flies emerge and reinfest the plants if the galls are allowed to remain on the damp ground.

STEM BORER

The young stems of the blueberry plant are often girdled during late June or July, 3 to 6 inches from the tip. Two parallel girdles or rings of punctures are cut around the stem about one-half inch apart, between which an egg is laid under the bark. The grub hatching from the egg is the stem borer (*Oberea myops* Hald.). It tunnels the stem and, if undisturbed, after 3 years emerges as

an adult. The first year it tunnels but a few inches, the second it may base or crown of the plant, and the third it may enter another ste crown. The adult is a slender beetle usually about five-eighths of an with dark antennae almost as long as the body. The body itself is b and the wing covers are black. The eyes are black and almost surrou of the antennae.

Control

Cutting the wilted tips well below the girdled area during July will keep this pest under control. Any missed at this time may be found while pruning. No tunnelled shoot should be left on the bush. The cut pieces may be thrown between the rows as the borer cannot get back to the bush.

CRANBERRY ROOTWORM

The cranberry rootworm, usually called *Rhabdopterus picipes* (Oliv.), has been a recognized pest for a number of years, both as a grub feeding on the roots and as a beetle feeding on the leaves of cranberries and other bog plants, including the native blueberry. Land covered naturally with these plants is commonly used for blueberries. When the land is cleared, the entire infestation is concentrated on the blueberry bushes planted there, and serious injury may follow. As indicated by the name, the grub of this insect attacks the roots, eating the bark off the large roots and completely consuming the fine roots. The injured plant turns yellow, wilts, and in extreme cases dies. The adult beetle measures about one-fourth inch in length and is shiny mahogany brown. It appears about the middle of June and is active above ground for about a month and a half. On cloudy days and at night it feeds on the foliage, cutting characteristic oblong holes in the leaves, preferably the lower ones. During the hottest hours of the day it hides in the surface of the soil or in any trash that may be present. Eggs are laid in the soil. The grub feeds on the blueberry roots until winter and again after hibernation until pupation time, late in May.

Control

The most satisfactory method of control is to plow the land a year before it is to be used and keep it fallow until planting time. Under such conditions the insects die for lack of food or they move to another field. In the absence of a large initial infestation, there is little danger from this insect. All seriously infested fields are ones that were planted soon after plowing. The beetles can be killed by chemicals if proper precautions are taken.

When wild land is not kept fallow for a year previous to planting, white grubs and other coleopterous larvae are likely to attack young blueberry plants, often killing them.

OTHER INSECTS

There are many insects that attack blueberries when they are set out in locations in which the insect is common. Japanese beetle, plum curculio, rose chafer, and European corn borer are but a few of the more common pests in garden plantings. Many of the commercial plantations are located near cranberry lands, and many of the economic pests are those attacking cranberries and native plants about cranberry bogs. The industry has not developed a special list of pests peculiar to the blueberry alone.

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